

PRELIMINARY DATA SUMMARY

April 1989

U.S. Army Engineer Waterways Experiment Station
Coastal Engineering Research Center
Field Research Facility
Duck, North Carolina

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CERC Field Research Facility
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

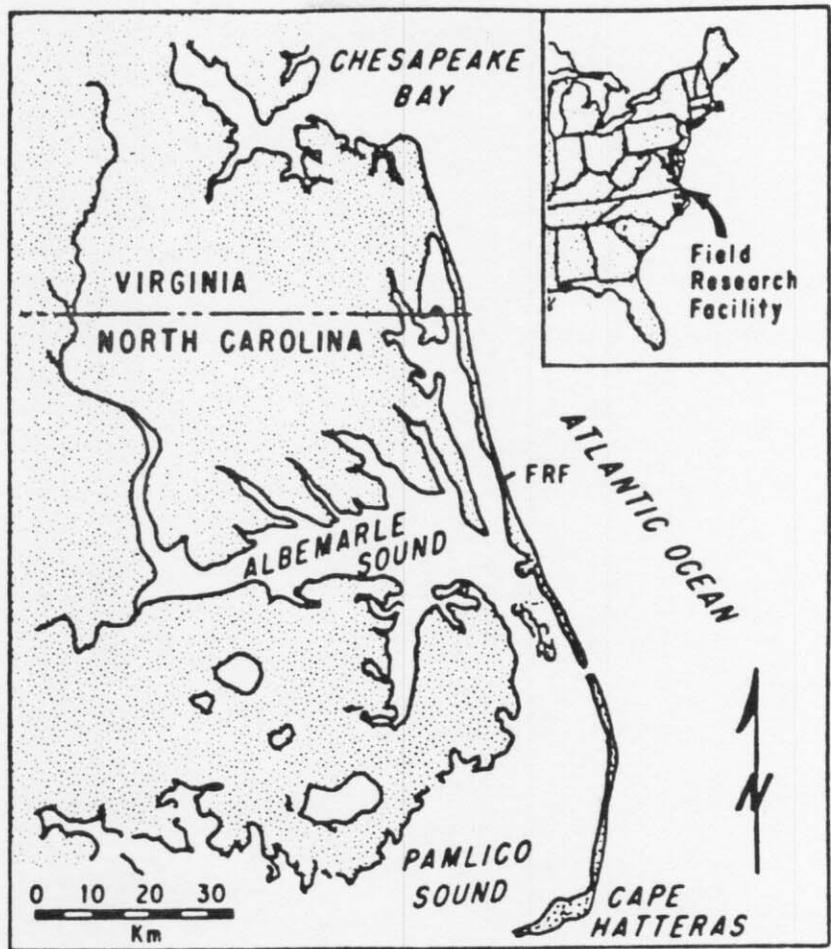


Figure 1. FRF location map

Table 1: Instrument Status/Data Availability

APR 1989

Gage ID	Description/Remarks	Depth at Sensor		Day of the month																													
				1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	2	2	2	2	2	2	2	3
616	Barometric Pressure		Gage Status	*****																													
			Data Collected	*** / *****																													
			Analog Record	*****																													
604	Precipitation		Gage Status	*****																													
			Data Collected	*** / *****																													
624	Air Temperature		Gage Status	*****																													
			Data Collected	*** / *****																													
632	Anemometer on Laboratory Building Elevation 19 m (NGVD)		Gage Status	*****																													
			Data Collected	*** / *****																													
645	Baylor staff at station 7+80 on FRF pier	see Figure 7	Gage Status	*****																													
			Data Collected	*** / ** / *****																													
625	Baylor staff at station 18+60 on FRF pier	see Figure 7	Gage Status	*****																													
			Data Collected	*** / *****																													
111	Pressure gage 309 m north of FRF pier (0.9 km offshore)	Approx. 7.8 m NGVD	Gage Status	*****																													
			Data Collected	*** / *****																													
630	Waverider buoy 6.0 km offshore	Approx. 23 m NGVD	Gage Status	*****																													
			Data Collected	*** / *****																													
679	Current meter 500 m south of FRF pier (0.6 km offshore)	see Figure 7	Gage Status	----- Gage Inoperative -----																													
			Data Collected	-----																													
865-1370	NOAA tide station at seaward end of FRF pier		Gage Status	*****																													
			Data Collected	*****																													
Supplemental Observations (daily oceanographic and meteorological observations)			Daily observation	*****																													

Gage Status	Daily Observation	Analog Record	Data Collected
Operational = *	Complete = *	Complete = *	All = *
Partial = /	Partial = /	Partial = /	Partial = /
Non-Operational = -	None = -	None = -	None = -

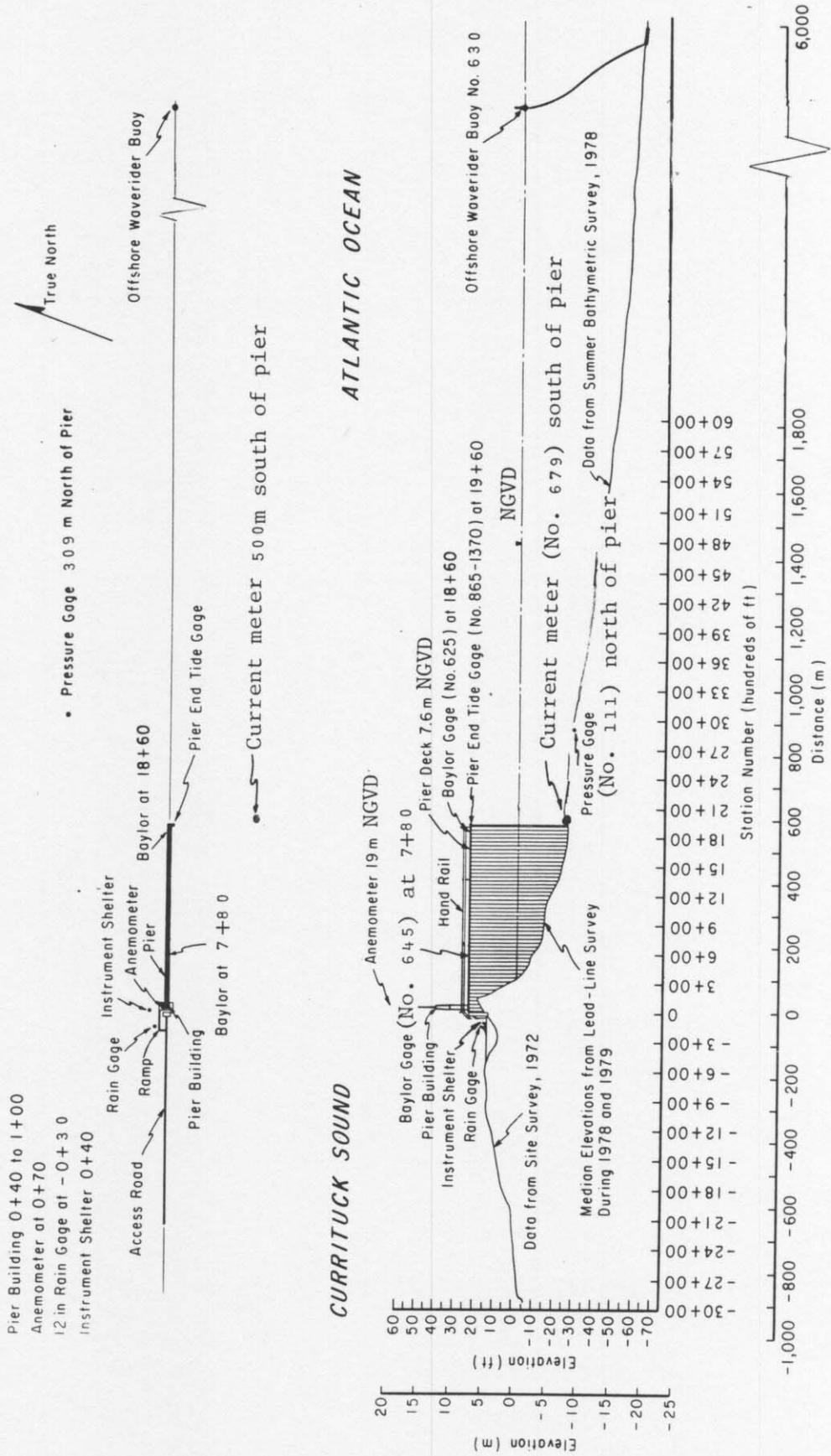


Figure 2. Instrument locations at FRF

PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured on top of the laboratory building at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(\text{C} \times 9/5) + 32 = \text{F}$
4. Meters per second (m/s) to knots (kn) -
 $\text{m/s} \times 1.943 = \text{kn}$

Table 2: Meteorological Data

Apr 1989

Day	Hour	Wind	Wind	Temperature	Atm	Precipitation
		Speed	Direction	deg C	Pressure	mm
		m/sec	deg TN		mb	
1	100	7	357	9.3	1006.4	0
	700	6	300	9.4	1011.8	0
	1300	5	285	10.8	1014.2	0
	1900	5	297	9.4	1018.6	0
2	100	4	284	8.6	1022.3	0
	700	6	22	8.2	1026.0	0
	1300	6	98	10.3	1026.0	0
	1900	5	135	9.6	1023.3	0
3	100	3	180	12.4	1021.3	0
	700	5	185	15.4	1020.3	0
	1300	9	202	21.6	1016.9	0
	1900	9	196	19.3	1015.9	0
4	100	6	191	18.5	1016.5	0
	700	6	187	19.1	1017.2	0
	1300	7	193	24.9	1015.9	0
	1900	7	186	20.4	1014.2	0
5	100	9	192	20.4	1014.2	0
	700		Power Failure			0
	1300	8	199	21.9	1014.8	0
	1900	6	197	19.4	1012.5	0
6	100	4	199	18.6	1008.4	0
	700	12	353	9.4	1010.4	13
	1300	2	11	10.4	1008.7	0
	1900	8	263	10.0	1012.8	0
7	100	6	235	10.4	1014.2	0
	700	3	121	11.8	1011.4	0
	1300	6	16	9.6	1003.0	10
	1900	12	229	9.5	997.9	9
8	100	10	281	5.5	1007.7	0
	700	5	263	8.4	1011.1	0
	1300	6	207	13.1	1010.1	0
	1900	2	186	10.1	1007.7	0
9	100	8	247	13.1	1005.4	0
	700	8	274	9.6	1010.8	0
	1300	4	239	14.1	1014.8	0
	1900	4	151	11.6	1017.2	0
10	100	3	219	11.7	1018.9	0
	700	0		10.9	1018.9	0
	1300	1	95	9.9	1019.6	0
	1900	7	32	9.4	1019.6	0
11	100	14	17	4.3	1021.3	7
	700	15	20	2.5	1023.3	19
	1300	12	13	5.3	1023.0	4
	1900	7	22	5.8	1023.3	0
12	100	8	17	6.3	1023.3	0
	700	11	32	8.0	1025.0	0
	1300	9	27	9.9	1025.0	0
	1900	9	15	9.5	1023.3	0
13	100	10	25	9.4	1020.9	0
	700	5	1	9.4	1021.3	0
	1300	3	64	12.7	1020.3	0
	1900	3	162	10.4	1019.2	0
14	100	2	57	10.2	1020.9	0
	700	5	52	10.8	1022.3	0
	1300	5	62	13.5	1021.6	0
	1900	3	158	12.9	1019.9	0
15	100	4	142	13.0	1018.2	0
	700	9	126	12.7	1014.2	0
	1300	6	174	18.1	1007.4	6
	1900	4	339	12.0	1004.0	7
16	100	6	296	13.2	1007.4	0
	700	6	287	12.6	1012.5	0
	1300	3	62	14.0	1014.8	0
	1900	4	125	11.7	1016.5	0

(Continued)

(Sheet 1 of 2)

Table 2: Meteorological Data

Apr 1989

Day	Hour	Wind Speed	Wind Direction	Temperature	Atm Pressure	Precipitation
		m/sec	deg TN	deg C	mb	mm
17	100	3	65	11.2	1019.6	0
	700	4	136	14.5	1021.3	0
	1300	5	129	17.1	1019.9	0
	1900	5	184	17.9	1017.2	0
18	100	7	213	16.2	1016.5	0
	700	8	221	17.1	1015.9	0
	1300	4	221	25.3	1013.1	0
	1900	5	186	20.8	1010.4	0
19	100	8	213	18.6	1010.1	0
	700	6	225	19.1	1010.4	0
	1300	10	12	11.5	1013.1	0
	1900	7	31	10.8	1014.5	0
20	100	6	46	11.2	1015.9	0
	700	8	24	11.7	1017.2	0
	1300	8	4	13.3	1017.9	0
	1900	7	29	11.7	1016.2	0
21	100	7	25	11.8	1015.9	0
	700	7	32	12.0	1014.5	0
	1300	6	359	13.9	1014.2	0
	1900	5	20	12.3	1012.5	0
22	100	2	279	10.2	1012.1	0
	700	5	298	13.2	1013.1	0
	1300	6	46	13.2	1012.5	0
	1900	5	111	12.5	1011.4	0
23	100	4	242	14.7	1011.4	0
	700	10	25	11.1	1013.5	0
	1300	6	42	10.6	1014.5	0
	1900	5	107	10.3	1014.2	0
24	100	4	122	11.6	1014.2	0
	700	2	95	13.8	1014.2	0
	1300					0
	1900	4	100	System		0
25	100	3	150	repair	1012.5	0
	700	1	129		1012.8	0
	1300	2	61	18.4	1011.8	0
	1900	6	180	15.2	1008.7	0
26	100	2	180	14.8	1007.7	0
	700	3	180	17.8	1008.4	0
	1300	2	85	23.4	1007.4	0
	1900	4	21	16.8	1008.7	0
27	100	0		15.5	1009.8	0
	700	3	20	15.6	1010.8	0
	1300	4	86	17.4	1008.4	0
	1900	2	135	17.6	1004.7	0
28	100	6	336	17.8	1004.3	9
	700	10	21	13.4	1008.7	0
	1300	9	14	13.3	1011.8	0
	1900	5	45	12.1	1012.5	0
29	100	4	104	14.1	1011.4	0
	700	5	117	15.8	1013.5	0
	1300	8	153	24.4	1012.5	0
	1900	6	156	21.3	1012.1	0
30	100	4	179	16.4	1012.1	14
	700	4	246	20.2	1014.5	0
	1300	5	34	19.3	1015.5	0
	1900	3	70	16.4	1017.2	0
		<u>Resultant</u>		<u>Mean</u>	<u>Mean</u>	<u>Total</u>
		1	41	13.5	1014.5	98

(Sheet 2 of 2)

PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all H_{mo} and T_p values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

Apr 1989

Day	Hour	645		625		111		630		
		Baylor Hmo,m	at 7+80 T,sec	Baylor Hmo,m	at 18+60 T,sec	Pressure Hmo,m	Gage T,sec	Offshr Hmo,m	Wvrdr T,sec	
1	0100	0.66	4.34	0.86	4.00	0.91	3.94	1.25	4.74	
	0700	0.69	5.82	0.76	5.95	0.84	5.57	1.07	5.57	
	1300	0.54	5.95	0.75	4.74	0.72	8.83	0.92	5.22	
	1900	0.56	5.33	0.62	4.74	0.65	4.66	0.82	5.33	
2	0100	0.32	4.74	0.46	8.83	0.44	8.00	0.56	7.31	
	0700	0.51	4.27	0.58	4.57	0.54	4.20	0.67	4.49	
	1300	0.54	5.45	0.58	5.33	0.60	5.12	0.66	5.22	
	1900	0.42	3.05	0.51	3.16	0.46	7.31	0.61	3.08	
3	0100	0.33	5.12	0.45	5.57	0.45	5.69	0.53	5.82	
	0700	0.30	5.33	0.41	5.57	0.41	8.00	0.55	4.92	
	1300	0.39	5.22	0.46	5.22	0.49	5.33	0.76	5.57	
	1900	0.45	5.95	0.60	6.92	0.66	7.31	1.01	6.24	
4	0100	0.45	9.14	0.59	8.26	0.68	7.11	0.96	6.74	
	0700	0.45	6.56	0.62	8.53	0.73	9.48	0.95	6.92	
	1300	0.64	5.33	0.69	8.83	0.78	8.83	1.01	6.74	
	1900	0.50	6.09	0.68	9.48	0.79	9.48	1.12	6.74	
5	0100	0.48	4.66	0.61	9.48	0.68	8.83	0.94	9.14	
	0700			Power Failure						
	1300	0.46	5.12	0.63	9.14	0.75	9.48		*	
	1900	0.58	5.69	0.78	9.48	0.80	9.48	1.18	6.40	
6	0100	0.48	4.83	0.63	9.48	0.71	9.14	1.06	7.11	
	0700	1.04	5.22	1.36	9.14	1.50	5.12	1.89	5.33	
	1300	1.12	5.45	1.04	9.14	1.09	5.69	1.25	8.83	
	1900	0.59	5.02	0.74	9.14	0.78	9.14	0.95	8.83	
7	0100	0.31	9.85	0.55	10.24	0.57	9.14	0.70	9.85	
	0700	0.31	9.85	0.49	9.48	0.56	9.85	0.64	9.48	
	1300	0.45	4.13	0.54	9.85	0.63	8.83	0.82	8.83	
	1900	0.71	8.53	1.08	9.14	1.13	9.14	1.55	7.76	
8	0100	*		1.32	6.56	1.54	7.11	1.80	6.74	
	0700	0.82	7.31	0.99	7.11	0.97	7.11	1.22	7.31	
	1300	0.64	8.00	0.69	8.00	0.79	8.53	0.87	8.00	
	1900	*		0.61	9.14	0.75	8.00	0.82	8.26	
9	0100	*		0.57	8.53	0.63	8.53	0.86	8.83	
	0700	0.33	8.00	0.46	8.53	0.46	7.76	0.61	9.48	
	1300	0.31	7.76	0.43	9.14	0.47	9.14	0.51	9.14	
	1900	0.34	9.48	0.48	9.48	0.49	8.83	0.66	8.53	
10	0100	0.25	9.48	0.44	9.85	0.47	10.24	0.54	9.48	
	0700	0.24	9.85	0.42	8.83	0.51	9.48	0.56	9.48	
	1300	0.23	9.85	0.44	9.85	0.50	9.85	0.56	9.48	
	1900	0.42	3.05	0.62	9.14	0.53	8.83	0.69	9.48	
11	0100	1.13	4.83	1.40	4.57	1.52	4.83	1.62	5.22	
	0700	1.58	6.74	1.91	6.40	2.10	6.24	2.14	6.56	
	1300	1.46	6.92	1.69	6.40	1.89	6.40	2.18	6.40	
	1900	1.23	6.74	1.49	8.83	1.57	7.11	1.61	6.09	
12	0100	0.89	6.40	1.23	9.48	1.32	9.48	1.26	9.14	
	0700	1.16	5.12	1.49	9.14	1.55	9.48	1.53	9.14	
	1300	0.95	5.69	1.47	9.48	1.50	5.82	1.52	9.14	
	1900	1.07	5.02	1.40	9.85	1.48	9.14	1.42	7.11	
13	0100	1.00	6.09	1.50	9.14	1.58	8.83	1.66	7.11	
	0700	1.47	7.31	1.71	8.83	1.72	7.76	1.75	8.26	
	1300	1.01	7.53	1.50	8.00	1.60	8.53	1.53	8.83	
	1900	1.11	9.48	1.25	9.48	1.53	8.53	1.32	9.14	
14	0100	0.71	10.24	1.16	9.14	1.28	8.83	1.28	8.53	
	0700	0.74	10.24	1.09	9.14	1.18	7.53	1.13	9.48	
	1300	0.63	10.67	1.03	10.67	1.08	9.48	1.05	9.85	
	1900	0.57	11.13	0.84	10.24	0.90	10.24	1.00	9.85	
15	0100	0.49	9.14	0.89	10.24	0.87	9.48	0.99	9.85	
	0700	0.51	10.24	0.76	9.85	0.84	10.24	0.90	10.24	
	1300	1.38	7.31	1.69	7.76	1.82	8.83	2.15	8.26	
	1900	1.32	9.85	1.63	10.24	1.75	10.67	2.29	9.85	
16	0100	1.03	10.67	1.55	10.24	1.67	10.67	1.74	10.67	
	0700	0.76	10.67	1.16	10.24	1.28	10.24	1.42	10.24	
	1300	0.67	9.48	1.12	10.67	1.24	10.24	1.16	9.14	
	1900	0.68	12.19	0.94	9.85	1.04	8.83	1.13	8.83	

* Electronic problems

(Continued)

(Sheet 1 of 2)

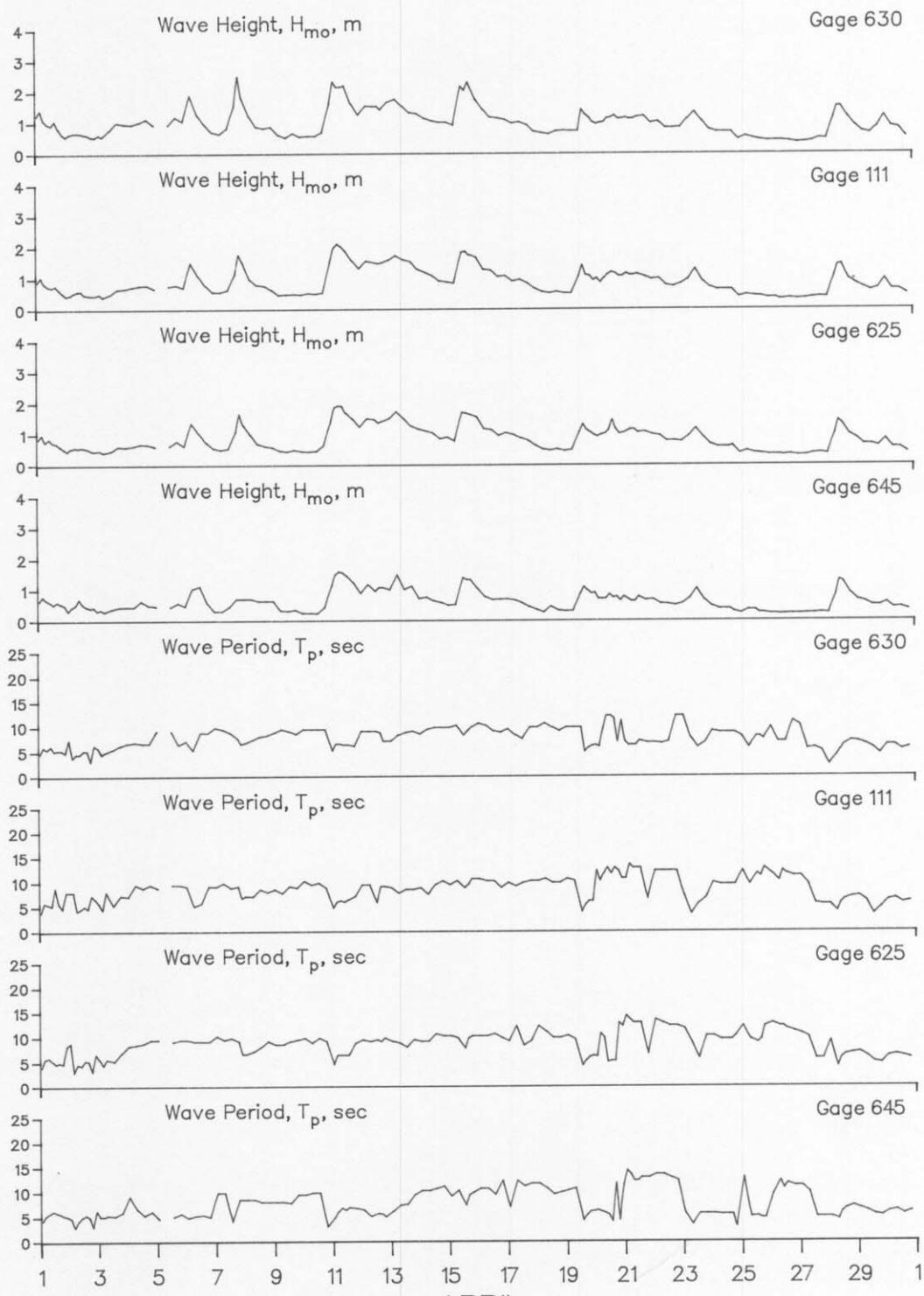
Table 3: Wave Data

Apr 1989

Day	Hour	645		625		111		630	
		Baylor Hmo,m	at 7+80 T,sec	Baylor Hmo,m	at 18+60 T,sec	Pressure Hmo,m	Gage T,sec	Offshr Hmo,m	Wvrdr T,sec
17	0100	0.69	6.92	1.03	9.14	1.06	9.85	1.08	9.48
	0700	0.66	12.19	0.97	12.19	0.90	9.14	0.96	8.26
	1300	0.56	11.13	0.86	8.26	0.95	9.85	1.00	7.53
	1900	0.44	11.64	0.78	9.14	0.83	10.24	0.91	9.85
18	0100	0.34	11.64	0.62	12.19	0.66	10.24	0.70	9.85
	0700	0.26	10.67	0.50	11.13	0.55	10.67	0.65	10.67
	1300	0.45	9.48	0.45	9.85	0.50	9.85	0.61	9.85
	1900	0.32	9.85	0.49	9.85	0.55	9.85	0.71	9.14
19	0100	0.29	10.24	0.44	10.24	0.50	10.67	0.73	9.85
	0700	0.30	10.67	0.47	9.48	0.50	10.24	0.72	9.85
	1300	0.85	4.20	1.05	4.20	1.04	3.88	1.25	4.41
	1900	0.97	5.95	1.12	5.95	1.09	6.09	1.25	5.69
20	0100	0.88	6.24	0.96	6.09	0.93	12.19	0.99	6.24
	0700	0.69	5.69	0.97	9.85	0.86	11.64	0.97	9.48
	1300	0.83	4.00	1.11	5.12	1.11	11.64	1.12	12.19
	1900	0.76	4.27	1.14	12.80	1.15	12.19	1.21	6.92
21	0100	0.76	14.22	1.02	14.22	1.06	10.67	1.11	6.92
	0700	0.61	12.19	1.14	12.80	1.09	12.80	1.10	6.24
	1300	0.75	12.80	1.04	12.80	1.12	12.80	1.15	7.11
	1900	0.65	12.80	1.06	6.56	1.04	6.56	1.19	6.74
22	0100	0.67	13.47	0.97	13.47	0.96	12.19	0.97	6.74
	0700	0.53	13.47	0.94	12.80	0.97	12.19	1.01	6.56
	1300	0.52	12.80	0.76	12.19	0.76	12.19	0.81	6.92
	1900	0.48	12.19	0.77	12.19	0.72	12.19	0.81	12.19
23	0100	0.54	5.57	0.74	11.64	0.81	7.31	0.82	12.19
	0700	0.70	3.41	0.91	8.83	0.95	3.51	1.09	7.76
	1300	1.02	5.57	1.17	5.69	1.28	5.57	1.31	5.82
	1900	0.66	5.57	0.89	10.24	0.89	6.74	1.02	6.74
24	0100	0.46	5.57	0.65	10.24	0.70	9.85	0.76	9.14
	0700	0.37	5.45	0.57	9.48	0.62	9.48	0.68	8.83
	1300			System down for repair					
	1900	0.29	3.01	0.61	10.24	0.43	9.14	0.51	7.31
25	0100	0.22	12.80	0.37	12.19	0.39	12.19	0.44	8.00
	0700	0.33	4.92	0.44	9.48	0.45	9.48	0.54	5.82
	1300	0.33	5.02	0.37	8.83	0.42	11.64	0.47	8.00
	1900	0.25	4.74	0.35	12.19	0.40	12.80	0.42	7.53
26	0100	0.21	9.48	0.32	12.80	0.35	11.64	0.39	9.85
	0700	0.20	12.19	0.32	12.19	0.36	10.24	0.39	6.92
	1300	0.20	11.64	0.30	11.64	0.31	11.64	0.35	5.82
	1900	0.20	11.13	0.33	11.13	0.33	11.13	0.37	11.13
27	0100	0.21	11.64	0.29	10.67	0.31	11.13	0.33	10.24
	0700	0.22	9.85	0.29	9.85	0.32	9.48	0.34	5.45
	1300	0.22	4.83	0.35	5.57	0.36	5.57	0.38	5.69
	1900	0.24	4.83	0.37	5.57	0.38	5.33	0.46	5.02
28	0100	0.22	4.83	0.34	9.14	0.38	5.33	0.45	2.31
	0700	0.81	4.34	1.00	4.00	1.04	4.00	1.12	4.13
	1300	1.25	6.56	1.32	6.40	1.43	6.40	1.50	6.24
	1900	0.86	7.11	0.98	6.74	0.95	6.92	1.15	7.11
29	0100	0.66	6.56	0.84	6.92	0.81	7.11	0.88	6.92
	0700	0.59	6.09	0.65	6.09	0.69	6.09	0.68	6.40
	1300	0.47	5.33	0.64	4.92	0.58	3.41	0.63	5.69
	1900	0.46	5.12	0.58	4.66	0.64	4.74	0.82	4.49
30	0100	0.55	5.95	0.81	6.09	0.95	6.24	1.19	6.24
	0700	0.39	6.24	0.54	6.40	0.62	6.56	0.84	6.24
	1300	0.41	5.45	0.54	6.09	0.61	5.69	0.80	5.33
	1900	0.33	5.95	0.40	5.69	0.49	5.95	0.52	5.69
	Mean	0.60	7.60	0.82	8.73	0.86	8.52	0.98	7.66
	Std dev	0.32	2.88	0.38	2.41	0.41	2.34	0.42	1.97

* Electronic problems

(Sheet 2 of 2)



APRIL
1989

PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data
Apr 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 619m Offshore Depth -4.8m (NGVD) ID #679		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	Speed	Dir
1	0100	-Along Cross Result										
1	0700	-Along Cross Result	34 3 34	S off 154	165	41 12 42	S off 143	North	35	S		
1	1300	-Along Cross Result										
1	1900	-Along Cross Result										
2	0100	-Along Cross Result										
2	0700	-Along Cross Result	8 4 9	S on 187	165	23 20 30	S on 202	North	24	S		
2	1300	-Along Cross Result										
2	1900	-Along Cross Result										
3	0100	-Along Cross Result										
3	0700	-Along Cross Result	16 16 23	N off 25	152	61 15 63	N on 326	South	27	N		Gage Inoperative
3	1300	-Along Cross Result										
3	1900	-Along Cross Result										
4	0100	-Along Cross Result										
4	0700	-Along Cross Result	27 15 30	N off 9	152	102 112 151	N on 292	South	43	N		
4	1300	-Along Cross Result										
4	1900	-Along Cross Result										
5	0100	-Along Cross Result										
5	0700	-Along Cross Result	19 15 24	N off 19	165	34 24 41	N off 15	South	99	N		
5	1300	-Along Cross Result										
5	1900	-Along Cross Result										

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

Table 4: Current Data (Continued)
Apr 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 619m Offshore Depth -4.8m (NGVD) ID #679		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
6	0100	-Along Cross Result										
6	0700	-Along Cross Result	38 6 39	S off 151	165	102 86 133	S on 200	North	35	N		
6	1300	-Along Cross Result										
6	1900	-Along Cross Result										
7	0100	-Along Cross Result										
7	0700	-Along Cross Result	13 8 15	N on 309	152	20 9 22	N on 316	South	27	N		
7	1300	-Along Cross Result										
7	1900	-Along Cross Result										
8	0100	-Along Cross Result										
8	0700	-Along Cross Result	0 26 26	off 70	140	20 8 21	S off 138	North	39	S	Gage Inoperative	
8	1300	-Along Cross Result										
8	1900	-Along Cross Result										
9	0100	-Along Cross Result										
9	0700	-Along Cross Result	11 6 13	S off 133	140	27 4 27	S off 151	North	14	N		
9	1300	-Along Cross Result										
9	1900	-Along Cross Result										
10	0100	-Along Cross Result										
10	0700	-Along Cross Result	7 0 7	N off 343	165	11 3 11	N on 326	South	22	N		
10	1300	-Along Cross Result										
10	1900	-Along Cross Result										

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

Table 4: Current Data (Continued)
Apr 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 619m Offshore Depth -4.8m (NGVD) ID #679		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
11	0100	-Along Cross Result										
11	0700	-Along Cross Result	51 51 72	S on 205	213	87 70 112	S on 199	North	48	S		
11	1300	-Along Cross Result										
11	1900	-Along Cross Result										
12	0100	-Along Cross Result										
12	0700	-Along Cross Result	68 34 76	S on 187	177	76 152 170	S on 223	North	30	N		
12	1300	-Along Cross Result										
12	1900	-Along Cross Result										
13	0100	-Along Cross Result										
13	0700	-Along Cross Result	11 0 11	S 160	274	4 9 10	N off 48	North	9	N	Gage Inoperative	
13	1300	-Along Cross Result										
13	1900	-Along Cross Result										
14	0100	-Along Cross Result										
14	0700	-Along Cross Result	9 0 9	S 160	226	14 3 14	N off 354	South	10	S		
14	1300	-Along Cross Result										
14	1900	-Along Cross Result										
15	0100	-Along Cross Result										
15	0700	-Along Cross Result	23 23 32	N on 295	238	47 23 52	N on 313	South	20	N		
15	1300	-Along Cross Result										
15	1900	-Along Cross Result										

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

Table 4: Current Data (Continued)
Apr 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	619m Offshore Depth -4.8m (NGVD) ID #679 Speed
16	0100	-Along Cross Result									
16	0700	-Along Cross Result	32 13 35	S off 138	226	13 5 14	N off 2	15 N South			
16	1300	-Along Cross Result									
16	1900	-Along Cross Result									
17	0100	-Along Cross Result									
17	0700	-Along Cross Result	13 0 13	S 160	207	0 0 0	 0	1 N South			
17	1300	-Along Cross Result									
17	1900	-Along Cross Result									
18	0100	-Along Cross Result									
18	0700	-Along Cross Result	6 3 6	N off 7	165	10 7 12	N on 303	19 N South		Gage Inoperative	
18	1300	-Along Cross Result									
18	1900	-Along Cross Result									
19	0100	-Along Cross Result									
19	0700	-Along Cross Result	4 5 7	N off 31	162	0 6 6	 off 70	30 N South			
19	1300	-Along Cross Result									
19	1900	-Along Cross Result									
20	0100	-Along Cross Result									
20	0700	-Along Cross Result	18 6 19	S on 177	177	24 7 25	S on 177	29 S North			
20	1300	-Along Cross Result									
20	1900	-Along Cross Result									

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

Table 4: Current Data (Continued)
Apr 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	619m Offshore Depth -4.8m (NGVD) ID #679 Speed	Dir
21	0100	Along Cross Result										
21	0700	Along Cross Result	34 17 38	S on 187	177	0 0 0		South	14	S		
21	1300	Along Cross Result										
21	1900	Along Cross Result										
22	0100	Along Cross Result										
22	0700	Along Cross Result	47 0 47	S 160	171	22 3 22	S on 169	South	8	S		
22	1300	Along Cross Result										
22	1900	Along Cross Result										
23	0100	Along Cross Result										
23	0700	Along Cross Result	18 9 20	S off 133	226	15 1 15	S off 154	North	12	S		
23	1300	Along Cross Result										
23	1900	Along Cross Result										
24	0100	Along Cross Result										
24	0700	Along Cross Result	14 2 14	S on 169	171	7 2 7	S on 174	North	6	N		
24	1300	Along Cross Result										
24	1900	Along Cross Result										
25	0100	Along Cross Result										
25	0700	Along Cross Result	18 5 19	N on 326	152	15 2 15	N on 331	South	3	S		
25	1300	Along Cross Result										
25	1900	Along Cross Result										

Gage Inoperative

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Concluded)
Apr 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	619m Offshore Depth -4.8m (NGVD) ID #679 Speed	Dir
26	0100	Along Cross Result										
26	0700	Along Cross Result	0 1 1		165	7 1 8	S off 149	North	6	S		
26	1300	Along Cross Result										
26	1900	Along Cross Result										
27	0100	Along Cross Result										
27	0700	Along Cross Result	36 27 45	S on 197	152	15 4 15	S on 174	North	5	N		
27	1300	Along Cross Result										
27	1900	Along Cross Result										
28	0100	Along Cross Result										
28	0700	Along Cross Result	28 4 28	S on 169	189	76 19 79	S on 174	North	30	S	Gage Inoperative	
28	1300	Along Cross Result										
28	1900	Along Cross Result										
29	0100	Along Cross Result										
29	0700	Along Cross Result	4 2 4	S off 133	177	0 0 0	0	North	19	S		
29	1300	Along Cross Result										
29	1900	Along Cross Result										
30	0100	Along Cross Result										
30	0700	Along Cross Result	8 9 12	N off 31	165	36 4 36	N on 334	South	18	N		
30	1300	Along Cross Result										
30	1900	Along Cross Result										

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

Apr 1989

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary			Temp.,C	Density g/cc	Secchi Vis.,m
1	0908	25	45	45	18	8.6	1.0256	1.5
2	0736	40		50	24	8.3	1.0256	3.7
3	0816	120			3	11.1	1.0250	3.0
4	0700	105			12	9.7	1.0258	3.4
5	0759	100			10	10.0	1.0254	3.0
6	0922	25		95	43	9.2	1.0258	3.7
7	0735	95			6	9.5	1.0258	2.1
8	0820	30			11	9.5	1.0240	1.5
9	0842	20		55	12	9.4	1.0250	3.0
10	0700	95			9	9.7	1.0240	3.0
11	0734	45	30	40	290	8.4	1.0244	0.6
12	0734	40		55	256	8.9	1.0212	0.3
13	0830	70		80	280	9.2	1.0220	0.6
14	0831	60	40	80	180	10.7	1.0220	0.9
15	0950	90		85	204	11.0	1.0220	0.9
16	0915	90		70	189	10.4	1.0234	1.2
17	0940	80	110		125	12.1	1.0220	0.9
18	0733	60			27	9.9	1.0248	0.9
19	0840	140			9	10.0	1.0252	1.2
20	0710	60	30	90	58	10.8	1.0246	1.5
21	0727	70		70	30	11.9	1.0220	0.9
22	0824	100		50	24	12.9	1.0208	1.2
23	1130	30		55	212	12.9	1.0212	1.2
24	0713	60	40		32	12.8	1.0220	1.2
25	0709	100	20		12	13.9	1.0214	3.0
26	0744	90			4	13.8	1.0227	2.1
27	0702	30			9	15.6	1.0200	3.4
28	0740	30		30	79	14.3	1.0221	2.1
29	0721	40			29	14.7	1.0220	2.7
30	0650	110		inoperative	9	15.6	1.0240	2.4

PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

FRF Tide Heights

Apr 1989

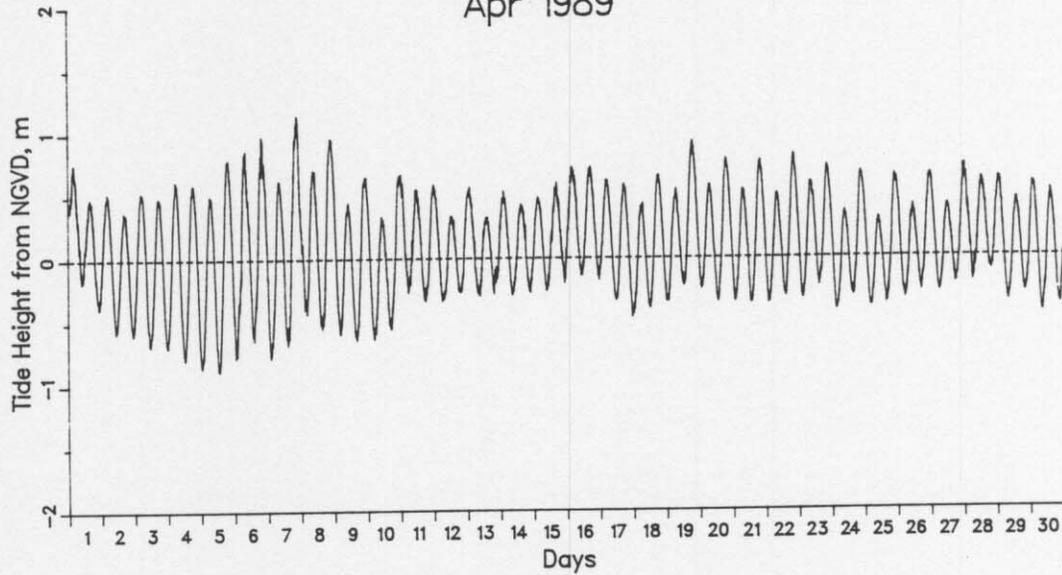


Figure 4. Water level time history

Monthly Water Levels, m NGVD

Extreme Low = -0.88 on day 5 at 1230 EST
Extreme High = 1.14 on day 7 at 2036 EST
Monthly Mean = 0.10
Mean Low = -0.41
Mean High = 0.60
Mean Range = 1.01

Table 6: Water Levels,m NGVD

		Apr 1989			
Mid-Cycle Day Time		Low	High	Mean	Range
1	612	-0.18	0.76	0.27	0.94
1	1837	-0.38	0.48	0.06	0.86
2	703	-0.58	0.52	-0.02	1.10
2	1928	-0.59	0.37	-0.09	0.97
3	753	-0.68	0.53	-0.06	1.21
3	2018	-0.69	0.48	-0.09	1.18
4	843	-0.79	0.62	-0.08	1.41
4	2109	-0.86	0.59	-0.12	1.44
5	934	-0.88	0.50	-0.16	1.38
5	2159	-0.77	0.79	0.03	1.56
6	1024	-0.64	0.86	0.09	1.50
6	2249	-0.78	0.97	0.07	1.75
7	1115	-0.67	0.62	0.01	1.30
7	2340	-0.43	1.14	0.31	1.57
8	1205	-0.55	0.70	0.08	1.25
9	30	-0.59	0.96	0.19	1.55
9	1255	-0.64	0.45	-0.09	1.09
10	121	-0.63	0.65	0.02	1.28
10	1346	-0.55	0.34	-0.10	0.89
11	211	-0.27	0.67	0.22	0.94
11	1436	-0.33	0.55	0.10	0.88
12	301	-0.33	0.59	0.11	0.92
12	1527	-0.27	0.34	0.03	0.60
13	352	-0.29	0.56	0.15	0.86
13	1617	-0.28	0.33	0.05	0.60
14	442	-0.29	0.53	0.12	0.82
14	1707	-0.27	0.43	0.09	0.70
15	532	-0.25	0.48	0.12	0.74
15	1758	-0.20	0.60	0.22	0.80
16	623	-0.14	0.72	0.30	0.86
16	1848	-0.17	0.73	0.29	0.90
17	713	-0.33	0.62	0.15	0.95
17	1938	-0.46	0.58	0.07	1.05
18	804	-0.39	0.43	0.01	0.83
18	2029	-0.34	0.66	0.15	1.00
19	854	-0.22	0.54	0.14	0.76
19	2119	-0.24	0.92	0.33	1.17
20	944	-0.34	0.57	0.13	0.92
20	2210	-0.34	0.79	0.22	1.13
21	1035	-0.36	0.54	0.10	0.90
21	2300	-0.36	0.77	0.20	1.13
22	1125	-0.30	0.51	0.12	0.81
22	2350	-0.32	0.82	0.23	1.14
23	1216	-0.22	0.60	0.20	0.82
24	41	-0.41	0.73	0.13	1.14
24	1306	-0.30	0.37	0.05	0.67
25	131	-0.38	0.68	0.12	1.06
25	1356	-0.36	0.41	0.01	0.77
26	222	-0.33	0.65	0.15	0.98
26	1447	-0.27	0.42	0.10	0.69
27	312	-0.27	0.66	0.18	0.93
27	1537	-0.21	0.42	0.13	0.63
28	402	-0.20	0.73	0.25	0.92
28	1628	-0.11	0.62	0.25	0.73
29	453	-0.35	0.62	0.13	0.98
29	1718	-0.28	0.46	0.09	0.74
30	543	-0.44	0.58	0.08	1.02
30	1808	-0.37	0.52	0.08	0.90

PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Zeiss surveying system; a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in March and the single survey in April on profile line 188, located 517 m south of the pier. Only two minor changes are visible including the removal of the berm (120 m) and a 45 m shoreward migration of the storm bar (240 - 320 m).

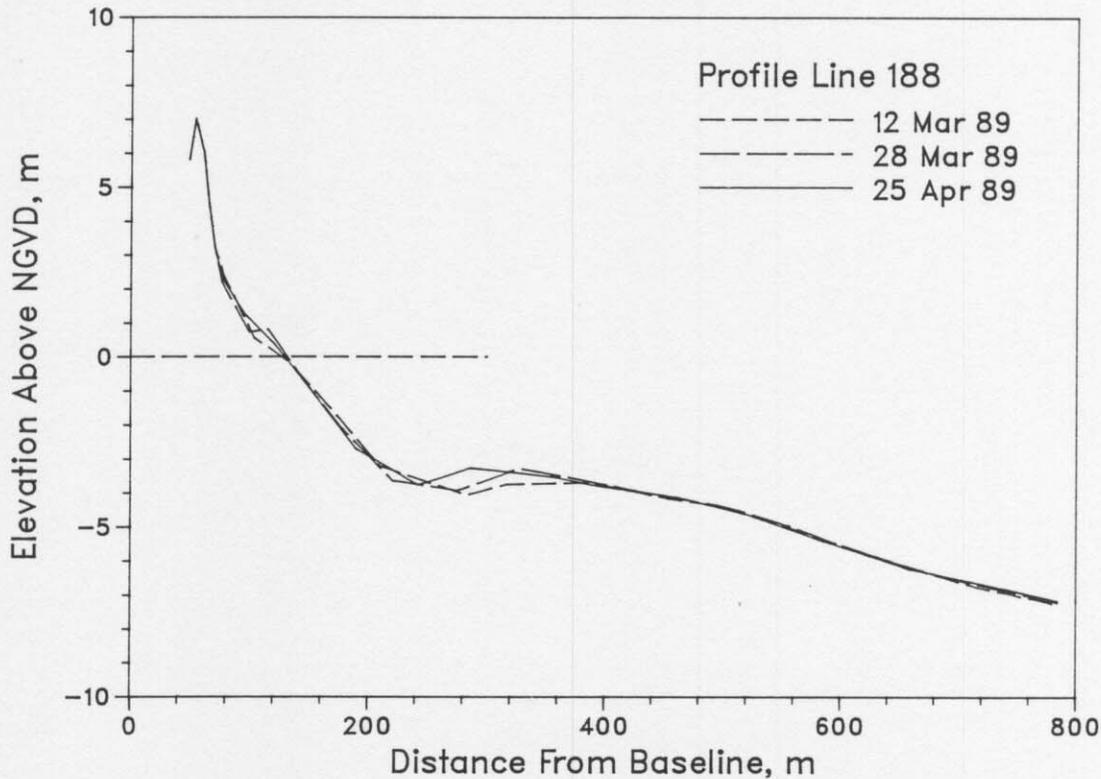


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1988.

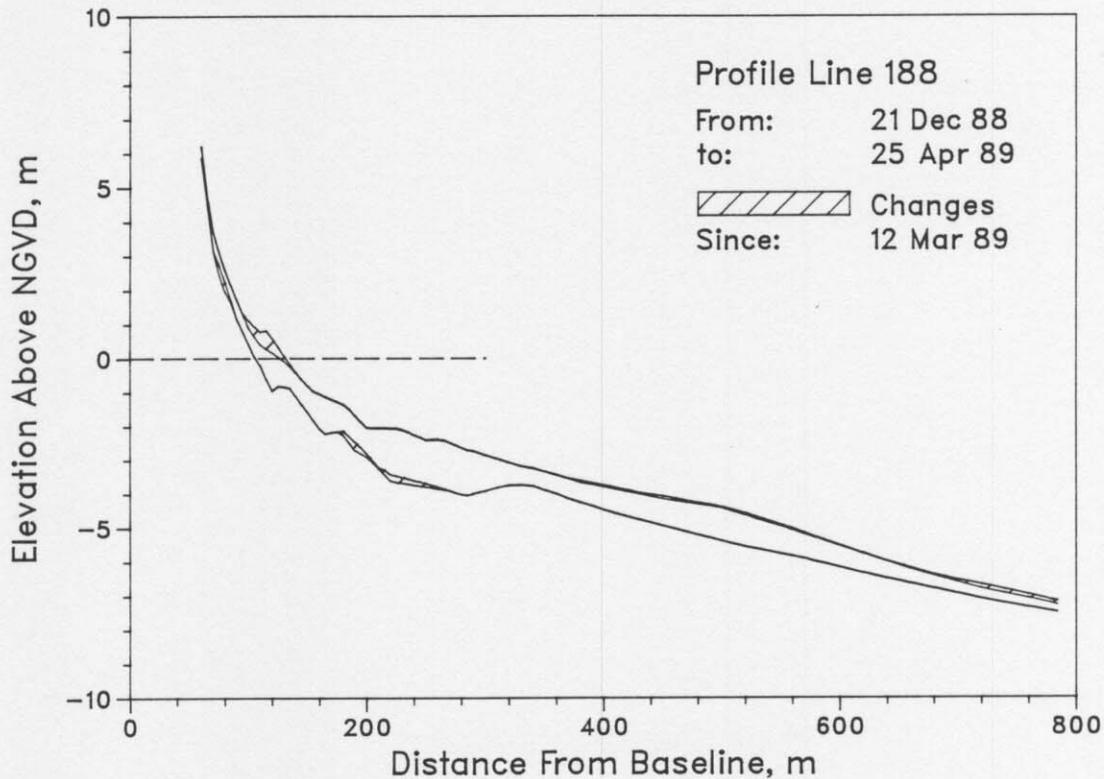


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 12 March. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition. The major shift of material offshore caused by the early March storm is clearly evident.

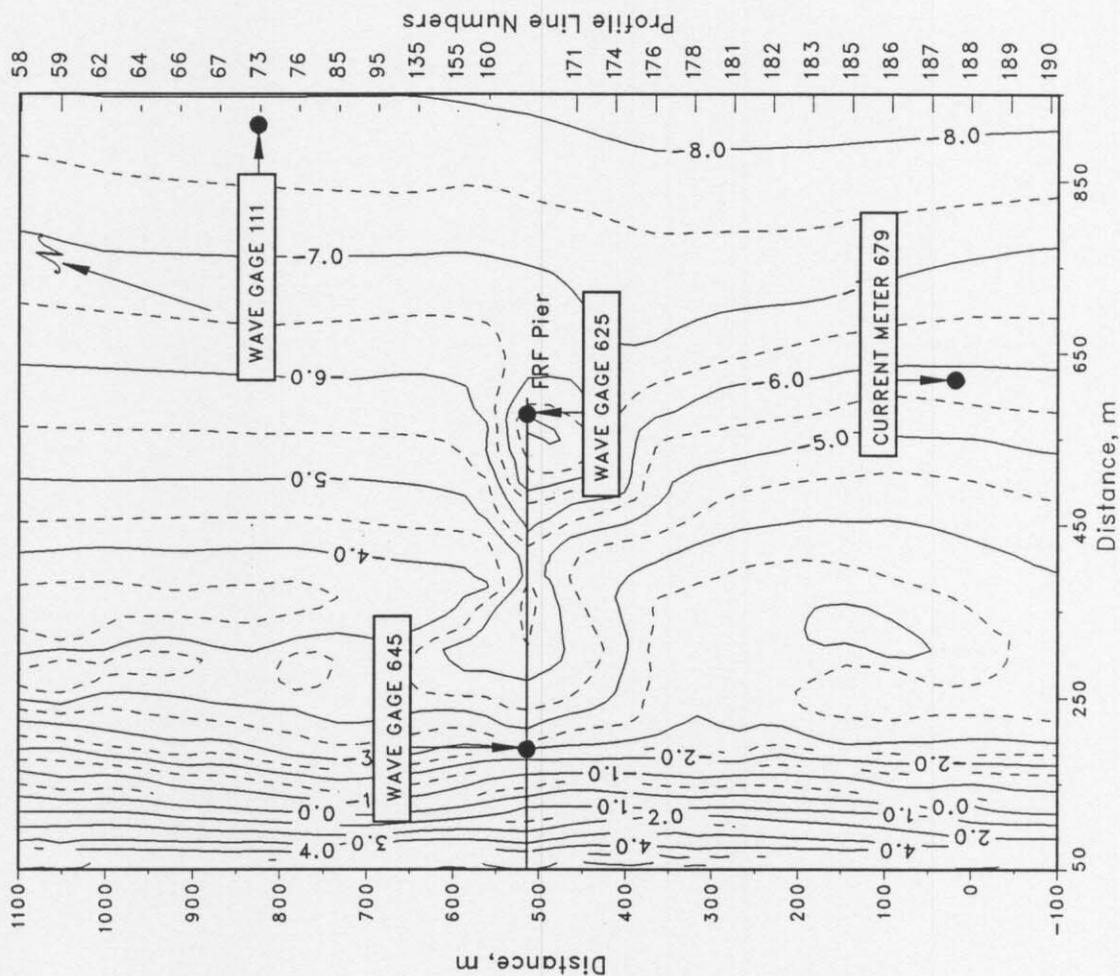
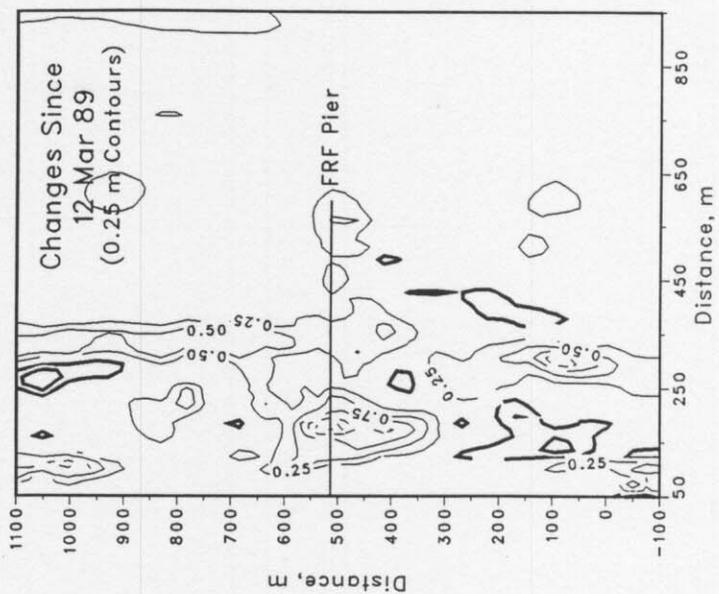
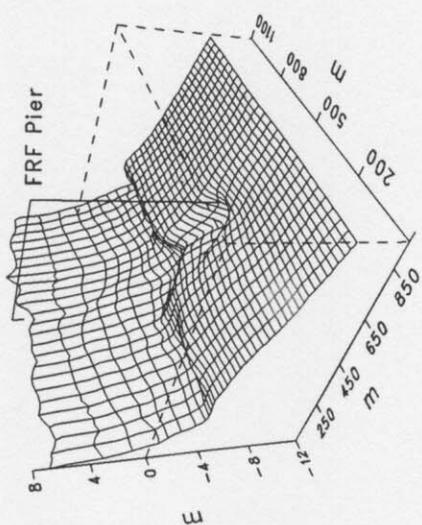


Figure 7. FRF bathymetry 26 Apr 89 (depths relative to NGVD)

VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the significant wave height at the seaward end of the pier (i.e. as measured at the end of the pier) exceeded 2 m and four contiguous 34 minute wave records were obtained every three hours:

<u>Start</u>	<u>End</u>
7 Apr (0508)	11 Apr (0542)

B. Storm Synopsis.

7-11 April - Developing well off the North Carolina coast on 10 April this minor storm remained stationary throughout the day, finally disintegrating on 11 April. Maximum onshore winds (from north-northeast) exceeded 15 m/s at 0208 EST, followed several hours later by the maximum H_{mo} (at gage 625) of 2.08 m ($T_p = 6.74$ sec). The atmospheric pressure only dropped to 1018.3 mb early on 10 April, indicative of the storm's weakness. Precipitation totalled 26 mm.

Distribution List

Government Agencies:

OCE	U.S. Geological Survey
BERH	U.S. National Park Service
NAO	U.S. Naval Academy
NASA/Wallops Flight Center	U.S. Naval Civil Eng. Lab
NOAA (NOS, NWS)	U.S. Naval Fac. Eng. Com.
SAD	U.S. Naval Oceanographic Off.
SAW	U.S. Naval Research Lab

Colleges/Universities:

California Inst. of Tech.	Stockton State College
East Carolina University	University of Akron
Florida Inst. of Tech.	University of Delaware
Harvard University	University of Florida
Naval Post Graduate School	University of Maryland
NC State University	University of Miami
Old Dominion University	University of North Carolina
Oregon State University	University of N. Colorado
Prince George's College	University of Rhode Island
Rutgers University	University of Virginia
Scripps Inst. of Oceanography	Va. Inst. of Marine Science
Southern Illinois University	

Others:

City of Va. Beach, VA	MEC Systems Corporation
Coastal Barge Corporation	Moffatt & Nichol, Eng.
Coastal and Est. Res., Inc.	Offshore Coastal Technologies
Coastal Science & Eng., Inc.	Mr. Rowland
Dr. Galvin	Mr. Savage
GEOMET Tech., Inc.	Sea Port Supply Corp.
Greenhorne & O'Mara, Inc.	Shell Development
Dr. Hylton	Sherwood Industries
Mary Marr, Inc.	Mr. & Mrs. Valpey
Mr. Mason	WCTI-TV
Masonite Corporation	SEASUN Power Systems

Foreign:

W. F. Baird & Asso. Coastal Engineers, Ltd (Canada)
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of New South Wales (Australia)
University of Sydney (Australia)